Journal of the Society of Arts.

FRIDAY, APRIL 13, 1855.

SEVENTEENTH ORDINARY MEETING.

Wednesday, April 11, 1855.

The Seventeenth Ordinary Meeting of the One Hundred and First Session, was held on Wednesday, the 11th inst., Edwin Chadwick, Esq., C.B., in the Chair.

The following Candidates were balloted for, and duly elected:—

AS ORDINARY MEMBERS.

Barlow, Wm. Henry, F.R.S.	Mair, Hugh
Dudgeon, John William	Melrose, James
Enfield, Edward	Swarbrick, Samuel
Gill, Samuel Lawrence	Symons, Alexander
Green, Henry	Trevithick, Frederick Henry
Green, Richard	Williams, Charles C.B.
Johnstone, James B., M.P.	Wood, Benjamin
Keener, John	Young, Charles D.
Kirtley, Matthew	Younghusband, Capt. C.W., R A.
Low, William	
Lycett, Francis	

AS A CORRESPONDING MEMBER.

Franscini, Federal Councillor.

On the table were exhibited specimens of a Miners' Safety Lamp, recently invented by Messrs. Whitehead. It consists of a strong cylinder of iron, with on one side a bull's eye surrounded by reflecting surfaces. The light given off is thus greatly increased. It has only one loose joint. The air to support combustion passes through a number of small openings round the oil receptacle, and thence through wire gauze, such as is used in the Davy lamp. The air admitted is purposely small in quantity. Wire gauze is also introduced at the top of the chimney, so as to complete the isolation of the flame. One of the lamps exhibited was for exploring purposes, where foul gases might be collected. A gutta percha tube is attached to the lamp, and is proposed to be used to conduct the air necessary to support combustion from some part of the works where it is sufficiently pure. In the event of the pipe being suddenly detached, no accident, it is said, could result, as the light would simply go out.

The Paper read was

ON THE MINERAL INDUSTRIES OF GREAT BRITAIN.

By Robert Hunt, F.R.S., Keeper of Mining Records.

Great Britain stands remarkable amongst the nations for the abundance and variety of her mineral productions;—and the inhabitants of those islands have through all historic times been noted for their skill in mining, and their successful prosecution of the metallurgic arts.

Long before Julius Cæsar thought of visiting those small "islands of the west," the merchants of Tyre sought for the tin which Cornwall produced. The Phœnecian mariners made regular voyages to our shores, for supplies of those metals which were employed in the manufacture of the bronzes of the Egyptians in the days of Moses, and those which decorated the palaces of the Assyrian kings in the meridian glory of that mighty empire.

The Welsh Triads tell us of the golden cars of the native princes, and of the chains of gold and silver which were used as the emblems of power—the production of the Cambrian valleys.

The Roman Emperor informs us that he was persuaded to the invasion of Britain by the reports of the wealth of the inhabitants in the useful metals, and even in the more precious ones of silver and gold.

Our kings through all the earliest periods of our history derived large portions of their revenues directly from the mining operations which they caused to be undertaken, or, such as were prosecuted by others under charters granted on conditions that large royalties should be paid to the Crown. In later days we find Prince Rupert the president of a mining company, and Oliver Cromwell an ironmaster.

Notwithstanding, however, the long and unwearying search which has been made over every part of the country for mineral treasures, we are now enabled to show that, not only are our national treasures unexhausted, but even to prove that yet larger drains may be made upon the subterranean wealth of these islands, for many years to come, without entertaining for a moment any fear of coming to the end of the "hoarded treasures."

My purpose is briefly to direct attention to the progress of our respective mineral industries; the state in which they are at the present time; and to examine, by the aids of science, with equal brevity, our future prospects. This will be most effectually done by attending to the historic relation in which the several metals stand to each other, although this cannot, in this essay, be strictly maintained in the divisions of the subject.

Tin, as already stated, was obtained at a very early period from these islands. The Cassiterides, or Tin Islands, were celebrated in ancient histories and in classic song. The Scilly Islands have frequently been considered as the Tin Islands of the ancients, although there is not the slightest evidence that tin was ever found in any quantity on them. Certainly, no tin is found at the present time in any of this interesting group of English islands. There can be but little doubt that the term Cassiterides was applied to the western promontory of this island, and if we look at Western Cornwall from the British Ocean, it assumes the appearance of a collected group of islands. Indeed, an alteration of a few feet in the levels of the land and ocean would at once give an insular character to that portion of Cornwall which lies westward of the line extending from Marazion on the south, to Hayle on the northern, sides of the county.

Regarding, after the most careful examination of all the evidences which have been brought into the discussion, St. Michael's Mount as the Ictis of Diodorus, I am disposed to believe that the tin districts westward of Helstone, and those around St. Austle, supplied the ancient world with the largest quantities of tin, which they knew so well how to use, although I cannot but think it probable that some may have been derived from the islands of the Indian Archipelago. Tin *mining*, in the strict sense of the term, was unknown before the time of the Romans. The Britons, or rather that tribe of them grouped under the general epithet of the Daumonii, who maintained themselves so long as a separate family to the west of Exeter, obtained the tin they used or sold by washing the drift deposits of the valleys; and from the evidences which have from time to time been discovered, the process of washing adopted by our ancestors was similar to that which may now be observed with the modern tin-streamer of Cornwall, or the gold-washer of Australia.

There are many evidences that the Romans made great excavations in search of tin; but subsequently the tin trade of Cornwall passed into the hands of the Jews, and the remains of Jews' workings—Jews' houses, &c., as they are called—sufficiently prove the extent of their search. They appear to have confined themselves to washing processes, or merely to have followed the veins appearing on the exposed faces of the rocks. We have no means of ascertaining the quantities of tin raised by the Jews, but it was less than half the quantity which has been produced in Cornwall during the last century. In the search of stream tin, it is curious to observe the circumscribed limits by which the streamer has been bound, the districts of St. Just, of Helstone, and St. Austle being the most marked. I do not intend to say that searches have not been made elsewhere; these, however, have been unimportant, and I feel convinced that many valleys formed by the vast granite ranges of Dartmoor, and other places, would prove remunerative to the labours of honest industry. Tin mining has been for some time carried on to a great extent, and it is considerably extending.

The total quantity of tin ore raised in Cornwall and Devonshire in 1853 was 8,866 tons, the average value of which was about £68 per ton. This black tin, or tin ore, produces on the average 65 per cent. of metallic, or white tin, as it is called. The quantity of this metal of British produce brought into the market is about 6,000 tons annually. Our annual imports of tin from Singapore, our Indian territories, from China, Peru, and Brazil, amount to 2,500 tons. Of this foreign tin there is re-exported about 1,000 tons, and of British tin rather more, annually.

The actual produce of five of the principal tin mines may be given. In 1853—

	Tons.		£	s.
Polperro produced...........	282	worth	18,998	12
Lewis...........................	262	,,	17,816	16
Gt. Poolgooth	260	,,	17,745	0
Boscundle	217	,,	14,507	0
Drake Walls	203	,,	15,397	11

In connection with this last-named mine it is necessary to name an improvement which has been effected in the purification of the tin ore. Much tin ore is contaminated with woolfram, which, as it cannot be removed by the ordinary processes of dressing, or cleansing, or by the operations of smelting, remains with the metal, and renders it of low value. At the Drake Walls Mine they employ a process invented and patented by Mr. Robert Oxland. This process is essentially one for effecting the combination of the tungstic acid of the woolfram with soda, by roasting and dissolving out the tungstate of soda formed, leaving the pure tin behind. Although at present there is no demand for the tungstate of soda, or for the tungstic acid, and it is allowed to run to waste, the increased value of the tin ore thus treated renders the process profitable. Mr. J. A. Phillips has also introduced a process for the purification of tin, which promises many advantages.

Attention should be directed to this curious metal—tungsten and its salts—since it appears highly probable that it may be rendered available for some important manufacturing purposes.

One of the purposes to which tin is applied is to enable the dyer and calico printer to give permanence to his reds and scarlets. For this muriate of tin is largely employed—it was expected that tungsten would have answered this end, and that thus a market might have been created for a new material. Hitherto, however, the experiments have not been successful. Mr. Young has patented a process by which stannate of soda is formed directly from the ore, and this preparation of tin is extensively employed.

It was formerly considered that tin was one of the superficial formations, and that it was useless to seek it at any great depth below the surface. A remarkable example of the incorrectness of this view exists in Dolcoath Mine, near Camborne. This mine was, more than a century since, worked as a tin mine, and proved exceedingly productive. As she increased in depth the mine became poor for tin, and exceedingly productive for copper, and as a copper mine was profitable for a long period. Eventually this mine became so poor that the water was allowed to accumulate in all the lower levels, and those near the surface alone were worked. At length a mining captain advised the removal of all the water from the mine. The recommendation was adopted, and now, at the depth of nearly 300 fathoms—far below the copper—an immense formation of tin is being worked. In 1853 there was produced from this formation 120 tons of tin ore, which was sold for £7,658 5s. 2d. Huel Basset, Huel Buller, South Huel Francis, are, strictly speaking, copper mines, producing, however, large quantities of tin at considerable depths.

All the tin raised in Cornwall is smelted in the county. The ore is easily reduced to the metallic state when combined with some chemical agent, which will, under the action of heat, abstract the oxygen or sulphur in combination.

Out of the tin produce arises another, but not very extensive, branch of mineral industry. This is the production of arsenic. Most of the tin ores which are obtained by mining contain both arsenic and sulphur. These are got rid of by exposing the powdered ores to the action of fire. They are calcined in peculiarly constructed furnaces, or roasted in places locally called *burning houses*. The sulphur and arsenic both sublime, but since they condense at temperatures slightly different, the arsenic can be separated, and it is, in its pure state, collected and sent into the market.

The quantity of arsenic produced annually has been estimated at 2,000 tons. The chief market for this is, however, now closed. The exportation of arsenic to Russia was very large, the principal portion being used in the preparation of Russian leather.

Copper for a very long period appears scarcely to have attracted attention. Tin mines were abandoned when the miner came to the *yellows*—the yellow copper pyrites. "The yellows cut out the tin" was a common complaint. About a century since attention was more particularly directed to the value of the copper ores of Cornwall, and from that time to the present the value of our copper mines has been continually increasing, until, in 1853, the copper raised in Cornwall alone was sold for £1,155,167 3s. 6d., and, in addition to this, Ireland produced 11,278 tons of copper ore; and some hundreds of tons were produced in Wales and the northern English counties. The importance of some scientific knowledge to our mining population is well exemplified by the fact that hundreds of tons of the grey sulphuret of copper have been thrown over the cliffs of the western shores into the Atlantic ocean; and hedges have been built with copper ores of twice the value of the ordinary copper pyrites. Immense masses of the black oxide of copper have from time to time been thrown aside. Eventually the miner became acquainted with the value of these ores, and they are now, of course, carefully preserved whenever they occur.

Amongst the most important of the mines yielding copper in this country are the

	Tons.		£
Devon Great Consols, which produced in 1853	24,120	at the value of	147,281
Huel Buller	18,562	,,	88,307
United mines	11,764	,,	62,598

Huel Basset, Carnbrea, West Caradon, and others.

There are in Cornwall at the present time about 100 copper mines selling copper ores by public sale, the ore which is raised giving on the average 6½ per cent. of copper. It will be well understood, that the smelting processes by which so large a quantity of matter has to be

separated, and so small a portion of valuable metal saved, involves many of the nicest chemical processes.

All the copper ore raised in Cornwall is sent to Swansea; this employs about 150 vessels and 800 seamen. The ships carry back coal to Cornwall, which is employed chiefly in the production of the mechanical force by which the water is pumped from the mines and the ores raised.

The smelting establishments of Swansea support, by their direct or indirect influence, nearly 15,000 people. Thus we have an example of the effects of a peculiar branch of industry rising up, at a distance from the locality in which the material sought for is produced. The importation of copper ores from the mines of Cuba, Chili, &c., would, it was feared, greatly reduce the value of the British ore. Now, although Cuba sends us 15,000 tons of her rich ore annually—Chili at least 18,000—and Peru, Spain, South Australia, and our other colonies about 20,000 tons more, the value of the Cornish copper ores has steadily increased, the combination of the two being necessary for the production of the best kinds of metal.

The Cornish pumping engine is, perhaps, the best example of the application of steam as a motive power which the world has yet produced. This has arisen from the necessity to which the engineers have been driven to effect a great economy of fuel in a locality so far distant from the coal fields, and again, from the circumstances that the duties of the engines are regularly reported, in what are called "Duty Papers." The sizes of these fine engines will be understood when the diameters of the cylinders of a few of them are given.

At the Consolidated and United mines they are	85 and 90 inches
At Poldice	90 ,,
At Huel Vor	100 ,,

The duty of a Cornish pumping engine is estimated by the number of pounds lifted a foot high by the consumption of a bushel of coals. Taylor's engine, at the United Mines reached the high duty of lifting 110 millions of pounds. The average duty of all the engines at present at work is 51,620,000, while the average duty of the best engines amounts to 99,000,000. This enormous power, which may be estimated at equal to the power of 5500 horses, is employed to raise more than 9000 gallons of water per minute from the mines, and to lift a large portion of the ore which is raised.

The manufacture of these engines gives rise to other and important industries, each of these large engines costing from £2000 to £4000. The machinery at one of the largest mines in Cornwall has been estimated to be of the value of £75,000. These steam engines are made in Cornwall, and the foundries employed in their construction are also largely engaged in supplying the water works of the metropolis and other districts with pumping engines. From estimates which have been carefully made, it appears that last year nearly 30,000 persons were employed in and about the Cornish mines. Of these 5500 were women, and 5000 children, the women and children being employed on the surface only. In one way and another at least 100,000 persons derive their means of subsistence from the tin and copper mines of Western England.

Mr. Mackworth has spoken of the health of our mining population, and from the attention he has paid to this subject, that gentleman is well qualified to express an opinion on the subject. I am, however, disposed to believe that the short average duration of the life of a Cornish miner is more directly due to the injurious effects of climbing than Mr. Mackworth conceives. When a man is engaged for an hour, or more, as is not unfrequently the case, in lifting his own weight upon perpendicular ladders, from a depth of 1800 feet, the amount of exhaustion produced is extreme. The constant effort made by the muscles of the chest eventually produces a disease of the lungs by which the poor miner is soon compelled to cease from labour, and in a few months after the attack comes on he usually ceases to live.

By the efforts of some benevolent gentlemen—urged on by Mr. Charles Fox—in connection with the Royal Cornwall Polytechnic Society, the sum of £500 was offered as an inducement to the miners to introduce some plan by which the miner should be relieved from this distressing toil. At Tresavean mine, they resolved on the adoption of a plan, by which perpendicular rods, with platforms fixed at every ten feet, should have reciprocating parallel motions. In this way at every stroke the miner on the platform moved through ten feet of space; he then shifts his position to the other rod, and is thus carried on another ten feet. In this way, without fatigue, the Cornish miner ascends and descends with much rapidity, time is saved and health preserved. In our coal mines, we find men lowered and raised by the winding machinery—many at a time—and with considerable speed—in safety. The Cornish miner's prejudices alone prevent the introduction of a plan which might be employed, in even the smaller mines, with economy and advantage, whereas now there are but four or five mines in Cornwall in which any mechanical appliances are made to this end. The use of guides in the shafts, and the employment of wire rope, appear to be two desiderata in the practice of metalliferous mining in the west.

The small quantities of copper produced in the mines of Wales, Cumberland, and Westmorland, scarcely require any further notice than that already given. The mines of Ireland promise to be of more importance than they have yet proved to be. English capital, and above all English industry, will it is hoped soon develope the mineral wealth of the sister kingdom.

Lead is produced over a very extensive range of these islands. This will be best understood by giving a list of the quantities of lead ore and lead produced in the different localities in 1853.

	Ore. Tons.	Metal. Tons.
Cornwall	6,680	4,690
Devonshire	3,014	1,798
Cumberland	8,343	5,619
Durham and Northumberland	19,287	15,041
Westmoreland	518	393
Derbyshire	7,681	4,959
Shropshire	3,508	2,528
Yorkshire	10,308	6,868
Cardiganshire	6,552	4,909
Carmarthenshire	921	692
Denbighshire	450	346
Flintshire	7,609	5,807
Montgomeryshire, &c.	1,597	1,114
Ireland	3,309	2,452
Scotland	2,799	1,919
Isle of Man	2,460	1,829

If to these are added 78 tons of foreign ores sold at Swansea, producing 52 tons of lead, we have a total produce of 85,121 tons of lead ore, or, 61,021 tons of lead. Nearly all the lead ore raised in this country contains more or less silver. The ores of Derbyshire and of the northern counties containing the least, while those of Devonshire and Cornwall contain the most. The average produce of silver from the lead ores of Devonshire is 40 ounces to the ton, those of Cornwall 35 ounces, those of the Isle of Man 20 ounces, of Wales about 15 ounces, of Ireland 10 ounces, and of our northern counties about 6 or 7 ounces.

Formerly it was not profitable by the processes adopted,—the oxidation of lead,—to separate the silver when it existed in less proportions than 15 ounces to the ton. By the process of desilverisation introduced by Mr. Hugh Lee Pattinson, it is now economical to separate the silver when no more than 5 ounces exist in a ton of lead. From this process an enormous amount of wealth has been added to the natural store. We now obtain from our lead

ores at least 700,000 ounces of silver, which may be valued at £92,500. A process has lately been introduced in which zinc is employed in combination with the fused metal; by the action of affinity the silver is thus readily separated. As yet this process is not extensively employed.

Beyond the important uses to which lead is applied, we have the chemical processes of white lead manufacture, in which, by a slow and interesting process, the lead is oxidized and converted into the carbonate or white lead. There is also the less known manufacture of a new white lead, which is an oxy-chloride of lead. This is produced by treating the ore directly with muriatic acid, precipitating by lime and the action of the oxygen of the air. It appears that this variety of white lead is coming into extensive use. The great value is, that it can be manufactured without acting injuriously upon the health of those who are engaged in the operations.

At the present time we are importing large quantities of silver ores from South America. These are smelted principally at Swansea, and in the neighbourhood of Liverpool, but there is some difficulty in obtaining an exact return of the quantity.

Zinc.—The history of zinc mining is somewhat curious. By various acts of parliament before and during the reign of Queen Elizabeth the exportation of calamine was prevented. This prohibition was founded on the belief, as expressed, "That our inexhaustible supplies of calamine would occasion large quantities of copper to be brought in for the manufacture of brass and gun metal." Calamine, or carbonate of lime, is found abundantly in the neighbourhood of the Mendip Hills, and in the northern counties of England: Black Jack, or the sulphuret of zinc, is discovered in many of the Cornish mines, and elsewhere. There are but two or three establishments in this country at the present time for the smelting of any of our zinc ores, nearly the whole of our supply being derived from the Vieille Montagne. There are few metallurgical processes more crude than the operation of reducing zinc to the metallic state, and there certainly is not one in which a richer reward awaits the skilful metallurgist who shall improve the process.

The manufacture of white zinc—the oxide of zinc—is a comparatively new industry, which is not, however, as yet carried out on such an extensive scale as it was expected it might have been when attention was first directed to its use as a pigment.

The oxide of zinc, or philosophers' wool, was observed by an early German chemist, Brandt, but the beautiful white formed by the combustion of the metal was not introduced as a paint until within the last ten years. The great objection to its use was the want of opacity in the particles of oxide, which, consequently, prevented it from covering as readily as the more opaque white lead. It has been found that, by regulating the action of the fire in the process a considerable opacity can be obtained; we may hence expect eventually, profiting by the experience of manufacture on the large scale, to secure a valuable pigment, which has the great advantage of not blackening under the action of sulphuretted hydrogen gas.

Manganese.—The oxides of this metal were formerly obtained in great quantities, and of peculiarly fine quality, from the mines at Lifton, near Tavistock, and from one or two other places in England. At the present time, although an abundance exists, and it can be worked at a comparatively small cost, it does not appear that we are able to compete with the German mines. All our large supply of manganese is now derived from the continent.

Manganese is employed principally as an agent in the production of chlorine gas, for the formation of the chloride of lime, unless where the gas is used directly as a bleaching agent. The oxide of manganese is used to decompose muriatic acid, and, consequently, having done its work, it remains powerless to effect further decomposition, and is thrown to waste. Attempts are now making, with much prospect of success, to restore the waste manganese to its original condition. If this is effected economically, it will be of much value to the manufacturer, but injurious to the proprietors of deposits of manganese.

This metal is used to a small extent in the production of some of the colours used on our best varieties of earthenware and porcelain.

Antimony is a metal for which there is not a very large demand. It is employed in the manufacture of type, and for a few other purposes. Our supply is principally imported. At one period considerable quantities were raised in Cornwall, but until recently, when one of the abandoned mines has been re-worked, scarcely any has been produced. There are several districts in Cornwall and Devon in which combinations of lead and antimony—ores well known to the mineralogist — exist in great quantities. These are not worked, owing to the difficulty of separating these metals from each other. Some specimens contain as much as eleven ounces of silver to the ton, and these, it would appear, should be rendered useful and profitable by some process which should economically secure the separation of the three metals, antimony, lead, and silver.

Nickel and Cobalt.—In the manufacture of German silver there has been an increasing demand for nickel. Cobalt is very extensively used in the potteries, and in our paper manufactories. Nickel is produced in small quantities in Cornwall, and on the Duke of Argyle's property in Scotland. Our supply is, however, mainly derived from the Norwegian and the German mines. Formerly considerable quantities of cobalt ore were obtained from Huel Sparnon, near Redruth. It exists in Dolcoath Mine. The Wherry, which was worked out in the sea near Penzance, produced fine specimens, in several of the tin mines of St. Just there are good samples to be obtained, and it is occasionally met with in the mines near St. Austle. Difficulties which have surrounded the purification of nickel, and the separation of cobalt, have naturally thrown the trade in these metals into a few hands. It is natural that those who are profiting largely by the efforts of their own industry, and the employment of their capital in a special direction, should cease to be anxious for the development of any sources of supply beyond those which they already hold. This mainly has led the nickels and cobalts of this country to be neglected: I am satisfied, however, that a diligent search would be rewarded by discoveries of more or less valuable stores at home of those articles which we are now deriving from foreign sources almost exclusively.

Of the less valuable metals, bismuth, molybdenum, and the like, we have many good examples, but the consideration of these need not detain us, as they scarcely form an item in the mineral production which we are considering.

Amongst earthy minerals, strontian and barytes, both carbonate and sulphate, are found in this country, the sulphates being in greater abundance than the carbonates. These minerals are worked in tolerable abundance in Cumberland and Westmoreland, and the increasing demand for the carbonate of baryta, has led to the introduction of a process for converting the sulphate into a carbonate. Amongst other uses for which the carbonate of baryta is employed, is that of using it as a base for the reception and retention of colouring matter in the manufacture of pigments.

Our clays are in the highest degree valuable. Of the finer varieties of the Cornish china clay, and the china stone employed for glazing, there is annually raised about 100,000 tons. This gives rise to the employment of 7,200 men, women and children in its preparation for the market, and not less than £240,500 per annum have for some years past been circulated in the neighbourhood of St. Austle alone. From Dorsetshire, again, large quantities of what is locally called "blue clay" are sent to the potteries. At least from 50,000 to 70,000 tons of this clay have been

sent out of Dorsetshire annually for many years past. Our manufacture of pottery may be regarded as a mineral industry; this manufacture has curiously located itself in North Staffordshire, yet, not one of the materials employed in the manufacture exists in the neighbourhood. The clays are derived from Cornwall, Devonshire, and Dorsetshire, the felspar chiefly from South America, and the buffalo hordes of that country supply the largest quantity of the bones used. Borax is brought from Tuscany, flints from the southern and eastern countries, lead and arsenic from the mining districts. Staffordshire producing alone, marl for the formation of the *saggars*, and the coal for firing the kilns and drying the clay.

Salt is of considerable importance as a mineral product. Droitwich and Nantwich are the great centres of its manufacture. In these places are produced annually about 65,000 tons from the brine springs. In the neighbourhood of Belfast a considerable discovery of rock-salt has been made; and during the past year it appears 2,000 tons have been raised and employed for home consumption, or exported in the rough state.

The most important of our mineral industries remain for notice. To our coal and iron we owe our present position in the commercial world; and, indirectly, our exalted point on the scale of civilisation. As the object of this essay is but to give a correct view of the extent and value of our mineral produce, it is not intended to enter into any details of the methods employed in raising the coal and iron ore, or to venture on any remarks as to their modes of occurrence.

Our argillaceous iron ores are largely associated with our coal measures; indeed, the three materials, iron-ore, coal, and lime-stone, required for the production of iron, are usually found in the same locality. Our coal and iron-fields are marked on our geological maps by large dark patches. The chief of these are the Scotch coal-field, extending, with a few inconsiderable breaks, from the German Ocean, west of Edinburgh on the one side, to the Irish Sea, beyond Glasgow, on the other. The Durham and Northumberland important coal fields, and the smaller one of Cumberland,—those of Yorkshire and Derbyshire, with the outlying patches in Leicestershire, Nottinghamshire, and Warwickshire,- the large field of Lancashire, with Cheshire and North Wales,—North and South Staffordshire,—the extensive area of South Wales, and the small district of Bristol and the Forest of Dean.

The clay ironstones are usually mixed, previously to fusion, with some hæmatite iron. This is obtained in large quantities in the neighbourhood of Whitehaven and of Ulverstone. During last year there were about 550 iron-furnaces in blast, producing each on the average 100 tons of pig iron weekly, or, allowing for accidental interruptions, 2,500,000 tons. The Scotch iron is manufactured principally from the black band ironstone, to which attention was first directed by Mr. Mushet. The difficulties of obtaining the black band are constantly increasing, and the expense of working as uniformly becoming greater,—these are the difficulties which the Scotch ironmasters have to contend with.

The discovery of the ironstone formations at Cleveland had given a remarkable start to the iron-making of the Tees and Tyne district. The ore obtained is, when compared with many of our formations, poor; and the quality of the iron has, it appears, yet to be improved. The Yorkshire iron is well known, that of Low Moor and Bowling being the most celebrated. The Cleator iron-works produce an iron made exclusively from the hæmatites; and near Ulverstone, at three furnaces, which are, however, worked only for four months each, the iron is made from the hæmatite smelted with charcoal. This is the only charcoal-iron now made in this country. In South Wales iron is made from the clay iron-stones, chiefly mixed with the ores obtained from Devonshire and Cornwall. In one district it is smelted with the bituminous coal; in the other, with the anthracite.

In Northamptonshire, large deposits of iron ore have been discovered; and very valuable iron formations have been traced, extending over Devonshire, from its northern to its southern shores.

The manufacture of iron is confined to the districts producing coal; for, although at one period all British iron was made with charcoal, now there is but one Iron Company employing wood.

Previously to, and during the reign of Elizabeth, there existed many iron-works in the counties of Surrey, Kent, and Sussex; and in Elizabeth's reign there was an Act passed prohibiting the erection of any new iron-works in these counties; and it was ordered that no timber, of the size of one foot square at the stub, should be used for fuel at any iron-work. This iron was made from the green sand formations of these counties, and it is not improbable, as Mr. Samuel Blackwell suggests, that Sussex may, by means of rail-roads, at no distant period, furnish the iron-trade with additional supplies of this important ore. As an example of the complete departure of a staple trade from a locality, the town of Thaxted, in Essex, may be cited. This was once the seat of our steel-manufacture, and was inhabited by wealthy merchant-cutlers. The failure of wood, and the use of coal in the manufacture of steel, transferred the trade to Sheffield; and Thaxted is now only remarkable for its beautiful church, and for being a comparatively large town, without any communication, direct or indirect, with a rail-road.

Time will not admit of any further examination of the curious and interesting subject of the progress of our iron manufacture. It appears that, in 1740, there were in England and Wales but 59 blast furnaces, making altogether 17,350 tons of iron; after 100 years we find the quantity produced amounting to nearly 3,000,000 tons; and, seeing the infinite variety of applications to which iron is now put, we cannot but think that still larger demands must be made upon the ferruginous stores which are spread over the whole island, from the older rocks of Cornwall and Wales to the recent geological formations of the eastern counties.

The situation of our principal coal deposits has been already described. These coal formations have been estimated as extending over nearly 10,000 square miles, while the coal-fields of Belgium do not extend over 600, and the fields of France occupy only about 1,719 square miles. Such is the relative value of our own and these European coal-fields. As nearly as they can be estimated, it would appear that the areas of the coal-fields of

England are	3,150	square miles.
Wales	2,160	,,
Scotland	2,000	,,
Ireland	2,300	,,
	9,610	

The area of the coal-fields of the British Isles has been often estimated at 12,000 square miles, but this, I believe, is far above the truth. Considerable difficulty has arisen in ascertaining the exact quantity of coal produced in the United Kingdom. This arises, in part, from the dislike of a number of the coal proprietors to allow the annual produce of the pits to be known. Various causes are assigned as an excuse for this, but from a visit paid to the various coal-fields I have been satisfied that all feeling of doubt and jealousy is rapidly dying out. Again, a very large quantity of coal is raised and used directly on the mines, which is never estimated, and in a very large number of the small collieries supplying the towns in their immediate vicinities no account is kept.

Data have been obtained for estimating our coal produce with a greater degree of exactness than has ever yet been reached. The computation will, however, occupy some considerable time, but in the meantime the estimates of Mr. Thos. Young Hall and Mr. Dickinson may be given, as showing a close agreement, although these estimates

are above those made by Mr. Thomas John Taylor. Mr. Taylor's estimate is—

	Tons.
For household purposes, about	19,000,000
For iron works	13,000,000
For steam, gas, and coking coal	9,000,000
Export	4,000,000
	45,000,000
Scotland has been estimated as producing ...	7,000,000
	52,000,000

Mr. Young Hall's estimate is as follows:—

Northumberland and Durham	13,300,000
Cumberland	1,000,000
Lancashire and North Wales	10,000,000
Staffordshire, Shropshire, and Worcestershire	8,000,000
Yorkshire, Derbyshire, Nottinghamshire, Leicestershire, and Warwickshire	7,000,000
South Wales, Monmouthshire, Dean Forest, and Bristol Fields	10,000,000
Scotland	7,250,000
Total quantity of coal raised per annum	56,550,000

Mr. Dickinson's estimate is:—

Northumberland, Durham, and Cumberland.	11,000,000
Lancashire, Cheshire, and North Wales	10,000,000
Staffordshire, Shropshire, and Worcestershire	8,000,000
Yorkshire, Derbyshire, &c.	7,500,000
South Wales, Monmouthshire, Gloucestershire, &c.	10,000,000
Scotland	7,500,000
Total quantity of coal raised per annum...	54,000,000

In producing this quantity of coal, we have about 233,650 workmen employed underground, and at least 50,000 on the surface.

Mr. Hall has been at considerable trouble to estimate the quantity of coal remaining in the Northumberland and Durham coal fields, and this he considers to be equal to 1,251,232,504 Newcastle chaldrons of 53 cwt. each.

By this estimate, at the present rate of demand, these coal-fields will be exhausted in 331 years.

I give Mr. Thomas Young Hall's estimate exactly as I find it, since I am not able to offer even an opinion on its correctness.

At the pit's mouth the value of the coal raised has been under-estimated as £9,000,000; it is certainly nearer £11,000,000; and at the place of consumption, £18,000,000; and £10,000,000 has been considered as the capital employed in the operation of mining our fossil fuel.

It is melancholy to find that, according to the very careful examination by Mr. Dickenson, 985 lives are annually lost in the collieries of this country.

The coal-fields of Ireland may be distinguished as the Leinster coal-field, which produces 120,000 tons per annum; the Tipperary coal-field, the produce of which has been estimated at 50,000 tons a year; the Munster coal-field, producing about the same quantity—but information on this is uncertain. These are anthracite coals.

Bituminous coal is worked in Tyrone, but the quantity is very small. The Connaught coal-field is more important, from which it appears 30,000,000 of tons may yet be raised. It has been estimated that the Mounterkenny part of this coal-field produces annually of

House coal	667,897	tons.
Slaty coal	400,820	,,

The southern portion producing—

House coal	345,369	tons.
Slaty coal	237,564	,,

Making a total of 1,622,150 tons.

In the Lough Allen district about 3,000 tons are annually raised. There are other districts in which, according to Sir Robert Kane, valuable deposits of anthracite and bituminous coal occur. These are, however, very inefficiently worked, and the quantity, which is small, produced, I am not enabled to ascertain.

The iron ores of Ireland possess many valuable properties in recommendation, but, like the mineral treasures of the Sister Island generally, they require further development. Of iron pyrites Wicklow furnishes annually nearly 100,000 tons, nearly the whole of which is sent to Liverpool, and employed in our sulphuric acid and soda manufactures.

The raw material of our several mineral industries may be approximatively estimated thus:—

Coal at the pit's mouth	£11,000,000
Iron	10,000,000
Copper	1,500,000
Lead	1,000,000
Tin	400,000
Silver	210,000
Zinc	10,000
Salt and other minerals	400,000
	£24,520,000

In this estimate, it must be remembered, neither clays nor lime are included—and there is yet the valuable produce of our quarries to be considered. The raw materials, therefore, which may be grouped under the present head, represent, at least, an annual increase of our wealth to the extent of £30,000,000. Notwithstanding the vast interest which is staked on the development of our mineral treasures, and the far larger interest which is vested in rendering this available for purposes of use or ornament, there has not been, up to the present time, anything like a system of education especially directed to these great industries.

Experience has done nearly everything for those engaged, and science but little. The work of science should be to carefully observe and record all the conditions under which our metalliferous ores occur. Nature ever works by fixed rules, there is no uncertainty in her operations, and the vast speculation which is so injurious to legitimate mining, the child of ignorance or fraud, is the direct consequence of the want of that exact observation and system of record, which would sooner or later establish some constants by which mining industry might be guided. Again, in our coal mines, there is much to be effected to enable the proprietor to work to greater depths than he has yet reached, that he may meet the demand increasing with an increasing population. At present the annual consumption of coal in the metropolis is one ton a year for every man, woman, and child, and in our manufacturing districts this is raised to three tons for each head.

Again, humanity demands that no effort should be spared to lessen the frightful loss of life which the operations of coal-mining produces. That nearly 1,000 men should be annually sacrificed by causes within the limits of remedy, for the purpose of giving us domestic fires and of feeding our manufacturing furnaces, is a sad reflection upon a community proud of its high estate, and anxious to maintain its position in the front ranks of civilisation, and in the great labours of Christianity.

DISCUSSION.

Professor Tennant would offer a few remarks upon the very interesting paper which they had heard read, as it was upon a subject in which he felt deeply interested, and he had recently been through the statistical part of it for the purpose of giving a lecture in St. Martin's Hall, on the occasion of the Educational Exhibition, which was reported in the *Journal of the Society*, No. 92, Vol. II., p. 680. On that occasion his object was to collect, as it were, the statistics, for the purpose of bringing together the different mineral products of the country, and he had

embraced in those statistics some productions which were not alluded to in the paper now before them, such as granite, limestone, and a number of others, of interest to this as a commercial country. He held in his hand a most valuable report, published by the government, bearing date 1839,* and he hoped Mr. Hunt, as he had ample means, would, by the aid of Government, be enabled to bring up the statistics of those minerals to the present time. He was confident that a great many varieties of limestone were lying dormant, which might be brought into practical use, of superior quality to those now used; and that with the present facilities of transport they might be employed for many purposes, beyond those to which they were at present applied and at a lower cost, whilst at the same time limestone was a material that was highly remunerative to the producer. He could mention an instance in which he had been called upon to give an opinion some little time ago, in which a landed proprietor, having sold only the surface soil for the purpose of constructing a portion of a railway, came upon a bed of limestone, which produced him a much larger amount of income than the rent of the whole property yielded. A railway had been brought into the vicinity, and they carried away the limestone, which was used for a variety of purposes, producing, as he had said, more income than the rent of the surface soil of the whole property. He would say a word or two with regard to limestone for building purposes. This was a most important subject, and one that might be carried to a considerable length. The report to which he had alluded, and which he was in some means instrumental in getting up, was brought forward at the instance of a petition to the House of Commons presented by Mr. Wise, member for Waterford, at the time when, the Houses of Parliament having being burnt down, it was thought a favourable opportunity for introducing a notice of British materials for building purposes. The report in question was laid before Lord John Russell, from whom it received a very favourable consideration, and who endeavoured to carry its suggestions into practice, and by means of the railways so extensively introduced throughout the country, they were enabled to bring up the material at a much lower cost than was formerly the case. Sand is not mentioned; this is used in the manufacture of glass; flints, used for macadamising the roads; slates, which were used very extensively, and gave employment to thousands of people in Bangor and other places. Sulphate of lime was another production of importance, being used in the manufacture of Plaster of Paris, in scagliola, and other things. There were some very interesting old monuments of this material in the Temple Church, in the Church of the Savoy in the Strand, also in Westminster Abbey, and more particularly in the churches in the Midland counties; and this material was now being used for a variety of manufacturing purposes. As a further illustration of the purposes to which it was applied, he need only refer to St. George's Hall in Liverpool, in which this material had been used very largely. Serpentine was another material to which he might refer. This was capable of being produced in very large quantities, not only in Cornwall, but also in Galway, where there was an inexhaustible supply of it, and of a quality superior to that of Cornwall, that from Galway being of a more compact consistency, and containing a less quantity of iron pyrites, steatite, and asbestos. Plumbago was another mineral production of considerable value. It had been reported in certain papers that ores of mercury had been found, but he had never seen any specimen of that production, and therefore perhaps it was only a report which sometimes got into papers, and it was necessary in discussions of this kind that such matters should be referred to, with a view, if possible, of correcting any erroneous impressions which might prevail upon the subject. Bismuth had been referred to in the public papers as having been found in Wales, but in two of the cases mentioned the substance proved to be magnetic iron pyrites, not bismuth. This brought him to that portion of the paper which referred to the lack of proper education amongst the mining community of this country, which was indispensable if they wished to work mines economically. He lamented the want of even an elementary knowledge of mineralogy and chemistry amongst those classes. Numerous attempts had been made, and were still being made, in this direction, and he hoped before long they would be crowned with success. If they compared the general knowledge of the working miner of the British islands with that of the working miner of Saxony, the superiority of the latter in that respect was abundantly proved. He would give them an instance of this. He went down a mine in Friburg, and he showed to a working miner there a specimen about which he (the professor) had some doubts, because he had not his blow-pipe with him at the time; the miner in question, having himself some doubts, pulled out his blow-pipe, and in 3 minutes he tested what the metal was with the greatest accuracy. He afterwards went into the Cornish district, and was introduced to a mining captain; he showed the captain two specimens of metal, and asked him what they were; he replied, mundic. These specimens were both different, one being iron-pyrites and the other arsenical-pyrites; but the captain had no means of proving what they were; had he, however, been acquainted with the use of the blow-pipe, a very simple instrument, which could be bought for a shilling, and the use of which could be taught in about a dozen lessons, he could have told, from the arsenical vapours that would be given off from a fragment not bigger than a pin's head, what the substance was. He might mention another instance of the same kind with regard to another substance referred to by Mr. Hunt, namely, tungsten. He had met with intelligent miners who could not tell the difference between tungsten and oxide of tin. This was easily distinguished by merely scratching the substances with the point of a penknife,—the tungsten would have a brown streak, whilst the oxide of tin was distinguishable by a pale grey streak. A number of other instances might be referred to, shewing a like ignorance of mere elementary matters connected with this branch of British industry. Thus, with regard to the ore of mercury, which was reported to have been found, a blow-pipe would have told in a minute whether such was the case or not. What was wanted in the mining districts was instruction in the first principles of mineralogy, and he hoped that the time was not far distant when every working miner would at least be acquainted with the use of the blow-pipe. The furnace cost less than a shilling, and the trouble was not considerable, and the miner might be made acquainted with it in the course of a month. Therefore, the difficulty was not great, but the prejudice, he was sorry to say was, but he looked to education speedily to overcome those prejudices.

Mr. Hunt begged to make one inquiry of Professor Tennant, which was induced by the observations of that gentleman relative to the alleged discovery of ore of mercury. When he (Mr. Hunt) was in Manchester, a week since, he was told that carbonate of copper had been obtained from Chat Moss, and it was stated that a large deposit of that ore had been discovered in that locality several feet in thickness. A specimen had been exhibited at the Royal Institution, in Manchester. He wished to ask Professor Tennant whether any such fact had come to his knowledge.

Professor Tennant said it was quite new to him. He apprehended the substance alluded to was a green or blue marl, and would probably turn out to be earthy phosphate of iron. He was constantly in the habit of receiving letters from parties inclosing small specimens, with the

* "Report of the Commissioners appointed to visit the quarries, and to inquire into the qualities of the stone to be used in building the new Houses of Parliament, August 27, 1839." Price 6d.

inquiry, "Is this gold?" or "Is this silver?" and in some instances, "Are these diamonds?" This was a matter of great importance to us as a commercial community. Our population became scattered over all parts of the earth, and settled, through the tide of emigration, in every latitude and longitude, and yet what did they know of their British colonies? Had it been reported ten years ago that in the next ten years £25,000,000 of gold would be obtained in Australia, the party would have been looked upon as a madman. If he asked what was known of the Cape—it was nothing; and it was the same with Canada; and, if they went through the entire British colonies they knew little or nothing as to their mineral resources. In Australia they had been throwing away oxide of tin, which was found there to a considerable extent.

Mr. P. L. Simmonds, being called upon by the Chairman to offer some remarks upon the mineral productions of our Colonies, in responding to the appeal, said, he was sure all present would feel the same satisfaction that he had done in listening to the very valuable details which had been read by Mr. Hunt on a subject upon which we had been hitherto lamentably deficient of accurate details, and had been obliged to grope our way in the dark, relying only upon vague and conflicting estimates of the value of any and each of our mineral products. Any one, therefore, entering this important field, possessed of the governmental advantages, scientific information, practical experience, and facilities of arrangement which Mr. Hunt had, and who placed so promptly and so readily the information he acquired before the scientific world, must do the State good service. It was only those who, like himself, were largely identified with the Press, and had frequent occasion in the course of editorial comment, and a comparison of our tradal progress, to require ready reference to facts and figures, who could fully appreciate the value of ample and recent statistics. Of reliable returns regarding our metallic products and mineral industries, those great sinews of our manufacturing wealth, we had been far behind many other countries, such as France, Belgium, and the Uuited States, where details on these subjects were most promptly and fully collected and distributed. There had, he knew, been a desire among our iron-masters, owners of collieries, and others, (which he was glad to hear, from Mr. Hunt's remarks, was fast dying out,) to withhold the statistics and details of their trade, from a mistaken notion that they might possibly furnish Government with data as to their production, which would be turned against themselves for future taxation. There was also a jealousy existing lest others might become as wise and as well-informed as themselves in certain processes, and learn the particular value of various mineral products. Mr. Hunt had shown that the extension of the area of our copper supplies had not been attended with any loss to the copper-miners of the West of England; for, on the contrary, as larger supplies had come in from abroad, the quality had been improved by the mixture of the ores, and the price correspondingly enhanced. Our mineral producers and miners might learn a lesson from other trades which feared to encounter competition. The shipping interest fancied the repeal of the Navigation-laws would be attended with disastrous results to their interests; but, although the foreign tonnage now employed in our trade and ports had increased in a triple ratio to that of our own vessels, every British ship had, nevertheless, been kept fully and profitably employed at very remunerative freights. So the agricultural interest was to have been annihilated by the policy of Free trade. But what had been the result? A greater demand and better prices for agricultural produce never prevailed than within the last few years, when our ports had been thrown open to immense supplies of grain and provisions from all the markets of the world. Mr. Hunt had confined his investigations, and, perhaps, properly so, to the mineral industries of Great Britain, and although, as he had told us, there was no fear of exhausting our subterranean supplies of fossil fuel and minerals at home for several centuries to come, it was satisfactory to know that there were other quarters of our own territories to which we might hereafter turn with confidence to meet the demand that would arise. The British empire was not confined within the narrow limits of the coasts and channels which circumscribed this island. In the words of the poet—

> "Far as the breeze can bear the billows' foam,
> Survey our empire, and behold our home."

We possessed in various quarters of the globe, some fifty colonies, all more or less rich in those subterranean treasures which had formed the subject of inquiry that evening, and wanting but skill, capital, and labour, to develope them to their fullest extent. The living tide of emigration which flowed towards those settlements, at the average rate of 1,000 souls per day, conveyed with it those necessary elements of development, and an occasionally extraordinary impetus was given both to emigration and to mining development in certain quarters. The Great Architect of the Universe, who, in His omniscient wisdom stored up for discovery and for use, at the proper time, those essential aids to settlement, to civilisation, to the extension of the human race over the face of the globe, and to their rapid advancement, by the aid of the metals, in all the arts and refinements which could encourage labour, increase comfort, shorten space, and extend the diffusion of knowledge, would seem, when the flow of the living tide grew sluggish—when a stimulus was required to sever the numerous links of old affections, relationship, and ties of country which cling around the human heart—to hold out, as it were, extraordinary inducements to tempt populations across the ocean, to induce them to face the dangers and privations incident to long voyages and early Colonisation. Hence, therefore, the gold discoveries had led to the peopling of countries to which no other inducement would possibly have drawn population in the same ratio, and States like California and Australia had risen into importance with a fairy-like celerity. Professor Tennant had incidentally alluded to the mineral productions of our colonies, and, if time permitted, he (Mr. Simmonds) would take a superficial glance at the progress they had already made, and the capabilities they possess for the future, for mining industry. Many present would, probably, be surprised at the extent and importance of this wide field. The very transport of crude ores to our shores last year gave employment to upwards of 200,000 tons of shipping, besides the large tonnage intercolonially employed. But the development of mining industry was fraught with numberless collateral advantages to the colonies themselves, to the parent State, and to the world at large. The extraordinary mineral productions of South Australia, had fixed attention upon that province, and by drawing thither British labour and British capital, raised it from a former state of bankruptcy to a thriving colony, with a revenue increased within four years cent. per cent. Although its metallic industries suffered recently to a considerable extent by the abstraction of labour from the lead and copper mines to the gold fields of Victoria, its continuous progress and prosperity were now assured facts. And, as a consequence of these discoveries, we found railways coming into operation, and the interior of the country opened up by steamers on that fine, but heretofore neglected river, the Murray, and its tributaries, navigable to the borders of New South Wales and Victoria. One interest, therefore, as Mr. Hunt justly observed, reacted upon another; for when population congregated around the mines, the agricultural and pastoral interests were likewise advanced, the means of transport were facilitated, shipping was attracted thither for cargoes, and interchange of commodities kept up, thus giving profitable employment to hundreds in the mother country. The copper and lead mines of South Australia appeared to be inexhaustible, and the periodical dividends of the Burra Burra Mine were a

valuable income to the fortunate holders. Spread over the whole of the Australasian group were metals and minerals of immense value. The coal of Van Diemen's Land, New Zealand, and New South Wales became of inestimable importance in a country where the supply of timber, as in the latter colony, was very limited; and now that the inter-colonial steam marine, which linked the several ports into one continuous chain, was so extensive, it might be that in after years, from this future Empire of the South, would emanate metallic productions as valuable, manufactures as extensive, trade as important,—carried on with the dense populations of China, Japan, the Eastern Archipelago, and the Pacific—nay, that would probably far exceed, what had been already developed in Great Britain. The gold fields of Victoria and New South Wales might be exhausted or rendered less productive by many causes, but the rich copper mines in South Australia, the iron and coal mines of New South Wales, would ever afford an independence to the hard-working operative. And as skill, education, and intelligence were brought to bear on the mining interests, other important discoveries, of tin, of slates, of granite, of limestone, and magnesian marble would be made. In New Zealand, coal, iron, and sulphur had been found; specimens of copper, of iron, of lead, and of silver had been met with in Van Diemen's Land, and the island possessed also several coal fields. If sufficient public spirit could be aroused to urge forward the development of those sources of wealth and national prosperity now entombed, he believed the generality of our colonies would not only rival, but probably surpass the mother country in the production of valuable metals and ores. In Labuan we had a valuable coal field, highly important to the interest of commerce and steam-navigation in the Eastern Seas. The tin-mines of Malacca had been already alluded to by Mr. Hunt; but in our Eastern Empire scarcely any progress had been yet made in mining. By the completion of the first section of the East Indian Railway of 120 miles, from Calcutta to Burdwan, the valuable collieries of the Bengal Presidency had been brought within reach of cheap transport; and, as the various projected railways there were carried out, the geological formation of the country and its mineral treasures would become more fully known. Another instance of the mysterious workings of Providence in peopling districts and furthering the interests of civilization, was afforded by the recent large discoveries of copper in Namaqualand, in Southern Africa. Whilst Britain had become indifferent to the progress of settlement in the Cape colony,—while difficulties and troubles had been created by mismanagement on the frontier, and collision with the native tribes, and we were drawing in our lines of circumvallation and abandoning valuable British territories to the Dutch Boers, attention became suddenly and forcibly directed to valuable lodes of copper on the extreme north-western borders of the Cape Colony; and, although the distance from Cape-town was many hundreds of miles, a desert intervened, and the difficulty of transporting machinery and supplies over some forty miles of country, without roads, from the sea, were immense; yet within a year a large European population had located itself there,—a considerable quantity of ore had been obtained,—a great deal of local capital and energy thrown into the field,—and commerce and civilization obtained a permanent foot-hold in what appeared one of the least promising quarters of Africa. As a consequence of these mining discoveries, extensive exploration had taken place, —the localities in the neighbourhood had been thoroughly surveyed,—the vast Orange River examined as to its capabilities of navigation, and as a means of communicating across the Continent to the Orange River Free State and Natal, and a steamer built here for merchants in the Cape had just been sent out for this river by his friend Capt. Messum. But we had another most extensive and comparatively undeveloped field of mineral production in our extensive North American territories. There was in British America a coal area twice as large as that of Great Britain, and the coal-mines of Nova Scotia were of a most profitable character to the General Mining Association, and could scarcely keep pace with the demand from the United States. Gypsum and grindstones were also large articles of export from the Lower British Provinces to America, and many thousands of tons of these were shipped annually. Iron ores abounded in Nova Scotia and Canada, which would hereafter doubtless be turned to very profitable account. He was only reading that very day a long and interesting list of the economic minerals collected in Canada by Mr. Logan, the provincial geologist, for transmission to the Paris Exhibition, and that list comprised magnetic, specular, and titaniferous iron ore; zinc, lead, and nickel; copper-pyrites, phosphate of lime, gypsum, shell-marl, and other mineral manures; slates, granite, lime-stone, sand-stone, and beautiful magnesian marbles; materials for pottery, glass, &c., besides various other products interesting to commerce. The copper-mines of Lake Superior, both on the American and Canadian shores, were now being prosecuted with energy, and the nature of the returns to the mining interests might be judged of from the fact, that huge masses, weighing from 6,000 to 7,000 lbs. of pure copper, were frequently obtained. The United States used about 9,000 tons of copper annually, of which not one-fourth was produced in their own territories, but they were dependent on British enterprise for the bulk of their supplies. In the far North-West we had extensive deposits of valuable coal, in Vancouver's Island, available for future use, and for the supply of the important State of California. As a result of this rough survey of our mineral treasures in the out-lying provinces of the British empire, we might perceive that there was no fear of any deficiency of supply, although the distance would offer some little obstacle. But as Mr. Hunt had shown us, it was possible to carry the manufacture, the skill, and the capital to the field of operation, and to raise up elements of prosperity where the raw material thus abounded. It was a proud reflection to think that, although the two great European powers, France and England, were now unfortunately engaged in war with a power which contributed creditable specimens of its metallic industries to the Great Exhibition of 1851, each State was still pursuing, with undiminished zeal and energy, the no less useful arts of peace. We were discussing now, calmly and deliberately, our mineral resources and metallic industries, and our ally was on the eve of opening its Great National Exposition, for the display of competitive skill from all quarters of the globe. Our merchant princes and producers had vied in transmitting thither specimens of their various industries—but the Demidoffs, and other merchant princes of Russia, could no longer enter the lists, being too deeply engaged in the arduous struggle which, for the interests of humanity, and the general progress of nations, it was fervently to be hoped might soon be brought to a satisfactory termination.

Mr. Hyde Clarke observed that periodical reports on the mining resources of the country were of great importance, because they not only showed the condition of existing interests, their progress or decline, but because they were calculated to point out new branches of enterprise, or to develope those now inconsiderable. In a time of war like this, or as it might in another sense, be termed, a period of commercial disturbance, this was the more particularly desirable, because some sources of supply or some channels of consumption being cut off, new materials, calculated to serve as substitutes, might be put forward under more favourable circumstances. The results accruing from the establishment of new branches of enterprise and new discoveries had been well shown by Mr. Hunt, in the case of silver. He would remark that the imported ores to which Mr. Hunt had alluded were antimonial silver ores and argentiferous copper ores, and although he had little practical acquaintance with English

copper ores, yet he was aware they contained silver; and looking to the prevalence of silver copper ores in Germany and other districts with which he was acquainted, he thought it very desirable that the copper ores of England should be examined with regard to silver, as they might prove a source of supply, adding largely to the 700,000 oz. of silver recorded by Mr. Hunt as produced in 1853. With regard to zinc white, although its use might be small here, so far as he was aware the consumption in the United States was large and increasing, and thus it became desirable to know the comparative progress of each branch of enterprise, to find a suitable market, for though in one country, or under one state of circumstances, we might fail, yet, profiting by that communion and connexion of commercial interests to which his friend Mr. Simmonds had alluded, a practicable means might be found elsewhere of successfully conducting the operations.

Mr. Murchison said, after the very able manner in which Mr. Hunt had brought the paper before the Society, he thought it would require very few observations from him to recommend that a vote of thanks be passed to that gentleman; and in so doing he would take that opportunity of expressing his concurrence, in a great measure, in the remarks of Professor Tennant, as to the great want of education that existed amongst the mining population of this country. He believed that nothing was a greater drawback to the progress of the mining interests of the country than this want of education. Professor Tennant had very properly remarked that in the districts of Cornwall there was a substance which was taken for mundic; and, although he agreed with the professor as to the vagueness of the application of the term itself, he could not agree as to the vagueness of the miner's knowledge as to the nature of it. He believed the substance which the Cornish miners took for mundic contained, in some cases, a considerable portion of arsenic, whilst in other cases it contained a considerable portion of iron; in fact, it might be said in all cases to contain a considerable portion of iron, and might be termed iron pyrites. But the instance of the mundic mentioned by Professor Tennant afforded a most striking example of the want of that description of education which was suited to the calling of persons engaged in mining operations. It was scarcely 100 years since copper ores were considered to be of any commercial value, and it was not till the year 1720 that any considerable quantity of it was raised from the mines of this country. He believed it would be found that the substance raised in Cornwall under the name of mundic contained many substances of commercial value. It contained a large per centage of sulphur, and, in some cases of arsenic, and in other cases, of silver, and there were cases in which each of these substances were found sufficiently abundant to render them of commercial value, although, as Professor Tennant had observed, the mundic was thrown aside as being of no value. It was scarcely 100 years since copper was thrown aside as valueless—tin was the only metal considered to be of commercial value; and, therefore, although the paper was not brought before them in what might be termed a technical shape, although the subject was not treated in a geological sense—they could scarcely overrate the importance of the paper now brought before them. It was with the greatest pleasure that he proposed a cordial vote of thanks to Mr. Hunt.

Prof. Tennant begged to second the motion, because it would give him an opportunity of adding a word or two of explanation. He admitted that mundic might be an extreme case, but there would be no difficulty in finding other cases of a similar description. The iron pyrites consisted of 46 parts of iron, and 54 of sulphur. They had simply to draw off the sulphur, and they had a metallic bead left behind, strongly magnetic; and in the other case of arsenical iron pyrites, which consisted of iron 36, arsenic 42, sulphur 21, a sulphuric vapour was given off, and the arsenic was perceptible from the garlic-like odour which was given off, thus indicating the presence of arsenic. These two substances had a similar appearance, but they were easily distinguishable by means of the blow-pipe, independently of the crystalline form. With respect to the silver ores referred to, any person who wished to read an interesting account of the discoveries of silver would find it in Darwin's "Journal of Natural History and Geology." That gentleman, who had travelled extensively in South America, gave a lamentable account of some of the British mining companies there. He gave an account of the cost of machinery, which was allowed to remain doing nothing, as they had no coal or other fuel with which to work it, and consequently very large sums of money had been spent in the purchase of machinery and sending out persons to find out the silver mines, whilst at the same time they had been formerly actually mending the roads of the country with silver ores.

Mr. Billings, after alluding to the variety of topics which had been introduced to the meeting, said, that the question of working granite and hard stone generally was likely to meet with a solution by the induration of soft sand stones, and upon these interesting experiments were in progress at Tonbridge. Sir Roderick Murchison's opinion was strong as to the success of the scheme, and he described the process as almost instantly changing the softest stone into an imperishable rock. The carver had all the advantage of soft stone in his work, and when finished it was easily rendered almost indestructible. It was a matter of grievous import to know that, as an educated people, our working classes were not upon an equality with those of the continent; but the fact was our children were set to hard manual labour the moment their tender hands could clutch a working tool, and they were compelled to work for the mere purpose of relieving the charge upon the parent. Thus we saw, at every step we took, distorted limbs and twisted bodies, instead of men walking erect, as intended by the Creator, and thus it was our labouring classes were uneducated. A simple law, compelling education up to a certain period of life, and prohibiting labour until the limbs were in some degree completed, would leave us a different race in a very short period. The remarks of Professor Hunt touching the black band formation in Scotland, appeared to Mr. Billings as exaggerated, for his belief was, that it formed a very small portion indeed of the iron working of that country, and no speculations, he thought, had been more disastrous than those which arose out of the purchase of estates for the supposed inexhaustible supply of black band ore. The melancholy loss of life connected with coal mines, in the same way as all other accidents connected with works of various kinds, were mainly owing to the carelessness of life and limb on the part of the workmen themselves; and if we took the statistics of railway accidents, at least three-fourths of them resulted from causes within the care and control of the sufferers. The masters were in all cases deeply interested in the safety of their men, the result of accident always touching their property, and it wanted only more care on the part of the workmen to induce greater precautions from the employers. Professor Hunt stated the coal value at the pit mouth to be eleven millions of pounds annually, and the quantity he estimated at sixty millions of tons, making but little more than 3s. 6d. per ton. Mr. Billings considered that twenty two millions of pounds would be much nearer and even under the mark, but if Mr. Hunt's estimate were correct, it would form a most interesting inquiry as to the progressively increasing value until the arrival in our London cellars, where, if the whole supply could come, it would amount to fully ninety millions of pounds.

Mr. George Darlington would offer one or two remarks upon the reduction of zinc. At present that operation was in a very crude state in England. They were reducing zinc in Swansea, by the English process, by a consumption of 25 tons of coals to produce one ton of spelter; whilst in Belgium the same amount was produced by the

consumption of about 7 tons of coals, and in some works in North Wales 6 tons of coals sufficed to produce a ton of spelter. He, therefore, thought they would do well to abandon the English process altogether, and adopt some plan analogous to that pursued in Belgium, by means of which an article of great commercial value might be brought into the market at a much less cost. Attempts had been made towards producing zinc by blast furnaces, and he thought that was a step in the right direction, and he had no doubt it might be made successful were it not that the gases of the furnace carried off a considerable portion of zinc with them—an evil which scientific research might be enabled to remedy. He hoped to see zinc reduced very much in price, inasmuch as it was an article that was capable of being manufactured into a variety of exceedingly useful forms.

The Chairman, in putting the vote of thanks to the meeting, asked for their indulgence to his bias as an official reformer, when he directed their attention to an administrative aspect presented by the reading of the paper they had heard that night by the Keeper of Mining Records. He (the Chairman) held that all Government departments should report publicly their progress and service, as a part of the accounts for their expenditure. Their officers should be encouraged to go out beyond their official precincts, and give information on points which might be interesting to science, or to the public at large, or to those immediately affected by their administration. The instance of the paper read on the previous night, by Mr. Mackworth, a Government Inspector of Mines, might be coupled with that of that night as partaking of the improvement desirable, giving points of scientific interest; indicating directions for improvements in practical art; and communicating business information to persons engaged in vast branches of industry. Where, from the nature of the subject-matter, it might be done, as in these instances, it would be of additional advantage to subject the accounts of official observation and progress to public examination, cross-examination, and discussion. It was to be hoped that those officers, as well as others engaged in departments having concern with the arts, would be allowed and encouraged from time to time to submit for discussion to the Society, whatsoever matters of progress, or of public obstructions to progress, occurred within their experience and observation. The official reserve, or the so-called dignity, which discouraged or shrunk from such discussion, was commonly a mere cloak to indifference, or ignorance, or imbecility. From ignorance of the great industrial interests involved in the institution of the School of Mines, so ably achieved and presided over by Sir Henry De la Beche, that very institution had been singled out in Parliament, and the low expense of conducting it denounced as an extravagance. Now, it was an under-estimate to state the value of the rude mining produce, unformed and unfashioned, at the pit's mouth, at twenty-six millions sterling. The losses provable from known payments upon shares, for concerns which failed from the ignorance which the survey and information collected by the School of Mines would correct—information beyond the power of private individuals to collect—exceeded, on the average, one million per annum. The whole expenses of the School of Mines—£14,000 per annum—were a trifling per centage on the products of the industry which it would serve to guide, or within one and a quarter per cent. on the present losses, which it would serve to prevent. The department had set an example which it was to be hoped would be followed over the whole field of the public service. Competitive examinations had been instituted for certificates of competency for the public service in the department. Although the public engagements to which those competitive examinations were intended to lead commenced at what for the public service was deemed very high rates, namely, £150 per annum, yet, so highly were the qualifications thus atained valued in the private labour market, that during the last year not one successful competitor could be obtained for the public service—they all at once obtained higher private emoluments. However inconvenient it might be for the department, the test afforded by this fact was decisive as to the value of the information which it imparted. It would be clearly worth while, as means to large economy of money, as well as life, to pay more for a larger staff and a stronger body of mining inspectors. Mr. Hunt had said that mining had hitherto been guided, not by science, but by experience. That which he described as experience was a rude groping in the dark, by rule of thumb methods, as contradistinguished from enlarged observation and comprehensive experience, constituting practical science. If, however, by processes admitted on all sides during the discussion to be so rude and imperfect, what might not be expected from a more instructed conduct of mining operations? That had been answered in part by the facts stated by Mr. Mackworth, as to the greater productiveness of the better instructed mining operations in France and Belgium. The most important points evolved during that night's discussion, appeared to him (the Chairman) to be the contrast afforded by Mr. Tennant, of the educated mining labour in Saxony, to that labour in the country which, as stated by Mr. Hunt, made hedgerows of valuable ores, and threw away some of the best products. The Prussian mining labour was of the same educated character, and was testified to be more productive in its results. It was more productive on the Continent, notwithstanding charges which here would be treated as unmitigated burthens, but which he (the Chairman) must contend were means to great economies, namely, responsibilities for not educating, or not employing educated agents and labourers. Education was placed at a disadvantage, when large employers, in such cases as mining operations, were enabled to throw upon others, as at present, some of the largest consequences of employing ignorance. About the time of the first Factory Commission, the Central Board were consulted by the Prussian government on the whole subject of the employments in mines as well as in manufactories, and they advised the adoption of the principle of imposing all the consequences as insurance charges upon the branch of industry. Though the principle was not adopted here, it was adopted in Prussia, and he referred to the following terms of the Prussian code in which it was applied:—

"Art. 214. The proprietors of mines are bound to take care of the miners who are wounded, or fall into bad health, in their service.

"Art. 215. When the provincial laws do not contain any express provision thereon, the person who works the mine shall pay to the sick or wounded workman four weeks' wages, if the produce of the mine does not cover the expense of the working, or if it be only just equal to it, or if it be required to defray the antecedent expenses of the mine; and when the mine produces a sufficient dividend, the workman shall be paid eight weeks' wages in case the illness lasts that length of time.

"Art. 216. If the illness last a greater length of time, the miners shall be supported out of the sick fund.

"Art. 217. The expenses of medical treatment and of the burial of a miner, wounded or killed by accident, shall be defrayed from the same fund.

"Art. 218. The widow of a miner has also the righ to claim the gratuitous wages fixed by Article 15.

"Art. 219. The gratuitous wages granted to the miner, in case of wounds or death, are not allowed if the miner have killed or wounded himself with premeditation, or by gross neglect, or by working otherwise than in the mine.

"Art. 220. If the wound or death has been occasioned by malice, or the gross neglect of a third person, the latter shall indemnify the sick fund and the proprietors of the mine."

Let him ask them to revert to the consideration of the comparative results, as shown by Mr. Mackworth the other night in his short table, where he said, " he might state that, from published Government Returns, the mortality from accidents was, in the coal-mines of

	Killed.	Persons.
Prussia	1·89	per 1,000 per ann.
Belgium . . .	2·8	do.
England . . .	4·5	do.
Staffordshire . .	7·3	do."

In the country where the assurance charge and responsibilities were at the highest, the so called accidents were at the lowest, or one-quarter those in England, whilst the money results and productiveness of the mines, as testified more directly, of France and Belgium, were better than in England. If, from the bad ventilation of the mines, there were an excess of sickness, the cost of that sickness fell not upon the parish or upon public rates, but upon the adventure, and the adventurers looked seriously to the practical means of prevention; if from ignorance on the part of the workmen Davy-lamps were misused, and destructive explosions were occasioned, the consequent loss of life, and orphanages, and widowhood, were charged upon the adventure, and there was no treating the ignorance of workpeople as an insuperable barrier to improvements, but the means of popular and practical education, and the selection of well-educated and trustworthy men were anxiously regarded as means of avoiding loss. In the mining and industrial statistics the whole cost should be given, including the cost of sickness, and premature mortality, and disability, which, he was convinced, would be found to be much greater than the public or the mining population themselves at present conceived. In the discussion, just complaint had been made of the deficiencies of the statistics on the subject. The Committee on Industrial Pathology were preparing to urge upon the Government the necessity of getting out the actual mortality, and the causes of mortality attributable to different occupations in different places. The deaths from violence amongst miners had been stated that night as upwards of 900; but according to Mr. Mackworth's return, of more than 4 per 1,000, they would exceed 1,200 per annum. Now he (the Chairman) had got out the numbers of the deaths in actual battle during the twenty-two years of the last war, and found that, exclusive of the wounded, they were 19,796, or 899 on an annual average. Thus, the whole deaths in battle, including the Peninsular campaign and Waterloo, and the whole of Nelson's battles, were exceeded by the violent deaths in the mines. But, from particular cases where he (the Chairman) had obtained returns, from Cornwall, Wales, and Cumberland, he found that one-fourth, or even one-third, was a proportion of violent deaths to the total deaths. Of the great body of 300,000 persons engaged in working our mines, possessing high qualities for cultivation, it might be said, that if the present modes of working continued, the whole were doomed to premature disability and ten years loss of life by excessive sickness, and that fifty thousand of them,—a body equal to the British army in the Crimea,—were doomed to perish, not with the glory and excitement of the deaths readily met in battle, but obscurely by explosions and horrible mutilations in mines, receiving comparatively little active sympathy, three-fourths of which sickness and deaths were proved to be preventible by means already in established practice.

Mr. Hunt in returning thanks for the high compliment which had been paid him, said he hoped they were on the eve of a change in their system with regard to the mining interests of the country. He had found a strong determination in Newcastle to found a school of mines, in which instruction of a purely technical character would be imparted. He was happy to say that the subject had been warmly taken up by the University of Durham, and no doubt it would be very shortly carried out. A similar determination also existed in North and South Staffordshire, and it was proposed to have one school at Stoke-upon-Trent, and another at Wolverhampton, whilst in Cornwall it had been determined to establish a school of mines at Truro, the teachers to which had been already appointed. A similar movement, he was happy to add, was going on in Bristol and the districts of South Wales, where an itinerant instructor went from mine to mine and delivered lectures of a practical nature to such as chose to attend them. He felt that the subject had been brought before the Society in an imperfect state, but on some future occasion he hoped to lay before them more satisfactory data than he had been able to do in the present paper.

Mr. Murchison remarked that the Chairman had alluded to the system in Germany, of the formation of a fund amongst the mining population for relief to the sufferers in cases of accident. He was happy to say that the same plan was carried out in the Cornish mines. It was part of the system there that a certain per centage of the wages should be appropriated towards the formation of such a fund.

The Secretary announced that the Paper to be read at the next meeting, Wednesday, April 18th, was " Notes on the Revision of Architecture in connection with the useful Arts; with a sketch of the Ventilation at St. George's Hall, Liverpool," by Dr. D. B. Reid, F.R.S.E.

INSTITUTE BOOK ORDERS.

March Account.

	Full Price. £	s.	d.	Red. Price £.	s.	d.
Barnsley, Mechanics' Institute	13	5	5	10	5	11
Brighton, Railway Literary and Scientific Institution	6	10	6	4	19	0
Bristol, Athenæum	6	2	0	4	10	4
Bromsgrove, Literary and Scientific Institution	13	7	4	10	12	10
Bury (Lancashire), Athenæum	2	18	6	2	5	8
Colchester, Mechanics' Institution................................	12	2	6	9	8	4
East Retford, Literary and Scientific Institution............	1	12	1½	1	6	3
Hants and Wilts, Educational Society	7	16	6	6	5	4
Hastings, Mechanics' Institution	7	4	0	5	11	3
Hereford, Permanent Library...	5	3	0	3	19	7
London, Bank of England Library and Literary Association	11	11	0	8	13	4
Macclesfield, Useful Knowledge Society	9	17	6	7	15	10
Odiham, Mechanics' Institution	5	14	0	4	4	6
Sevenoaks, Literary and Scientific Institution.................	1	2	11	0	19	0
Stamford, Institution	0	19	4	0	16	2
Tamworth, Library and Reading Room	8	13	0	6	11	6
Wells, Literary and Scientific Institution.......................	5	0	8	3	17	0
Whitehaven, Mechanics' Institution..............................	16	0	0	12	10	3
Woburn, Literary and Scientific Institution.................	9	15	0	7	13	1
	£144	15	3½	£112	5	2

Being a saving of £32 10s. 1½d., or about 23 per cent.

Home Correspondence.

STATISTICS OF THE IRON MANUFACTURE.

LETTER III.

SIR.—I should not have requested the insertion of a third letter on the Statistics of the Iron Manufacture, if it had merely reference to a desire to bring the matter before the public; indeed, I should have thought such a course unnecessary after the subject had been noticed as it has been by Mr. Gladstone, in your *Journal* of the 16th instant, and I do hope that his remarks "may produce good fruit."

With regard to that gentleman's letter, he could not, in my opinion, have said anything more to the purpose with reference to the general arrangement of a plan for carrying such a measure into effect; and, surely, government, with Earl Granville and Mr. Jas. Wilson, M.P., connected with it—the former largely interested in the iron trade, and both aware of the advantages of correct information—may, if their attention be drawn to the subject, be induced to lend their powerful aid to give an impetus to the inquiry.

The object, however, of my present letter is to show the advantage with which some arrangement of statistics relating to the manufacture of iron, might have been introduced into Prof. Wilson's paper "On the Iron Industry of the United States." It was to me, at the time, a matter of great regret that I had not an opportunity of being present to hear that paper read. I had looked forward to it with much interest. I considered that Mr. Wilson had fortunately been placed in a position to convey, through the columns of your *Journal*—a channel equal, if not superior, to any other, as the medium of communication with the intelligent classes—a fund of valuable information relating to the cost of the manufacture of iron, in the raising and carriage of the raw materials, labour, and charges, so as to act as a guide to our manufacturers, and give a complete insight into the operations of our principal customer, and, as some imagine, our future rival—no one ever had so good an opportunity for collecting and making known this much required information. On reflection, I feel pleased that I was not present, as it gives me a better claim to express in writing my regret that, with the opportunities afforded to Mr. Wilson, his commission would appear to have been confined almost exclusively to the localities of the raw material, rather than, in addition thereto, to the cost of raising those materials, conveying them, and working them in the furnace.

Mr. Wilson's paper contains the following facts:—

The iron ores are found in most of the States, and comprise every variety known in Europe. The principal district of the present iron manufacture is Pennsylvania; the coal and ironstone are not here found together. "The ores and the fuel have to be sought for in different localities." "In general the wrought-iron works are carried on as a distinct business from the manufacture of pig-iron." "The principal cause of the separation of the two branches, is probably due to inadequacy of capital to carry on both." Mr. Wilson divides the principal districts into seven heads, giving the quantity of pig-iron made in each, and stating the cost to average from 15 to 25 dollars per ton. He says: "as long as the price of English iron prevents its importation into the Union under 20 dollars per ton for pigs, and under 50 dollars per ton for bar iron, the home manufacture can compete profitably with it in their markets, and the iron industry of the States will flourish and increase.

"The fluctuations in the make are very considerable; in 1840, the quantity made, according to the census, was 286,903 tons, or, by another statement, 347,700 tons; in 1842, 225,000 tons; 1846, 768,000 tons; 1847, 800,000 tons; 1849, 650,000 tons; 1850, by the census, 540,000 tons, or, according to a statement of the Statistical Committee of the Ironmasters' Convention, considerably less, the difference in Pennsylvania alone being 86,890 tons. In 1853-4 it is supposed a large increase took place." The present state of our iron market will probably, as in former instances, occasion a reduction in the make of the United States.

The information given by Professor Wilson is in itself most useful, and very interesting, but it affords little help as a guide to our manufacture.

Of Renton's process it is not necessary here to speak—somewhat similar experiments have been tried in this country, but the general nature of the materials, and the character of the trade, do not hold out much prospect of extensive operations—neither as to the exportation of iron ore, which must be a *far* hereafter, if, which does not appear at present probable, it should ever to any extent be attempted.

When Mr. Cambreleng, in 1830, proposed a modification of the tariff—the friends of the measure, and those opposed to it, prepared statements to support their views; amongst these returns I find some which give an idea of the information which might be made available. Thus, in Pennsylvania, the estimate of making bar iron from pigs was 75 dollars, including the value of the pigs, 26d. 67c.; iron ore to a ton of pigs, 2½ to 3 tons, at 5 dollars per ton; coal to a ton of pigs, 220 bushels, at 5 cents per bushel; and for making a ton of bars from pig iron, 175 bushels, at 6 cents per bushel.

Also with respect to the bearing of the manufacture on agriculture, "The following calculations are derived from the average returns submitted to the Committee from two counties, (those most engaged in the manufacture of iron in Pennsylvania), namely, Centre and Huntingdon, and have been carefully verified by a comparison with returns from 73 furnaces and 132 forges.

For each ton of bar iron and castings made, the following agricultural product is found to be consumed:—

		Cents.	Dols.
25 bushels of wheat and rye, averaged at		75	15
57 pounds of pork	,,	5	2·85
43 ,, of beef	,,	4	1·72
10 ,, of butter	,,	12½	1·25
2 bushels of potatoes	,,	30	60
Half-a-ton of hay	,,	7 dols.	3·50
For every ten tons of bar iron, one horse is employed one whole year, worth 100 dollars, and experience shows that the mortality among horses so employed is per annum one in seven, and constitutes a charge of per ton			1·43
For fruit and vegetables, of which no return has been made, we feel justified in putting down . . .			1·00
Total dollars			27·35

Every five tons of iron, as above made, requires one able-bodied man throughout the year. The average wages of the workmen is fully one dollar per day, or say 300 dollars per annum, equal to 25 dollars per month.

The expence of transporting this iron to the different markets, by land and water, may be estimated at an average of ten dollars per ton.

The average wages of 1830 do not materially differ from the rate of wages as given in the Census of 1850:—

Average per man per month	on pig iron	20·76 dols.
,,	on castings	27·38 ,,
,,	on bar iron	25·41 ,,

Any reduction in the cost, therefore, at the present time, must arise from the greater facilities of procuring the raw materials, and economy in their use, assisted most materially by the hot blast, without which the anthracite—a somewhat doubtful fuel—would be almost useless in the furnace.

To give some idea how dependant the American

manufacture at present is on the fluctuations in our trade, as shown in the increase and decrease of their make, I add the following statement of the average price of pig iron at Glasgow, and bar iron at Liverpool, New York, and Pittsburg, for ten years—from 1843 to 1852 inclusive. I give it in dollars and cents:—

	1843.	1844.	1845.	1846.	1847.	1848.	1849.	1850.	1851.	1852.
PIG IRON.	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.
Glasgow	10·89	17·16½	18·39	16·21½	15·73	10·72¾	11·03	10·72¾	9·68	11·05
New York	26·28	30·53	32·91	34·58	30·83	25·34¾	22·93½	21·07½	20·62½	22·48
Pittsburg........	22·00	28·00	28·30	27·90	29·90	27·60	24·20	23·20	23·00	31·60
BAR IRON.										
Liverpool........	23·51	25·98	41·07	43·31	45·12	31·89	29·04	25·08	24·28	28·57
New York	57·00	62·00	67·75	77·50	73·75	60·00	47·50	43·50	36·00	39·75
Pittsburg........	59·00	60·00	60·00	59·00	59·00	59·00	53·50	53·00	45·00	51·00

In 1842 the duty on pig iron was fixed at 9 dollars per ton, and on bars at 25 dollars per ton. In 1846 the duty was altered to 30 per cent. *ad valorem* on pig and bar iron, in fact, on all descriptions. In the present year a Tariff Bill was introduced in the House of Representatives to reduce the duty to 24 per cent. *ad valorem*, but the iron-masters and agricultural interest uniting, threw it out in the Senate.

I will conclude this, I fear too long letter, with a statement of the exports of British iron and ironwares for the years 1852, 1853, and 1854, which, besides its bearing on the subject now under consideration, enables me to complete my paper, inserted in your *Journal* of the 15th Dec., to the latest period, which, at the time I read it I was unable to do for want of the official returns:—

EXPORTS OF BRITISH IRON, HARDWARE, CUTLERY, MACHINERY, AND MILL WORK.

Quantity.	1852	1853.	1854.
	Tons.	Tons.	Tons.
Pig iron	240,491	333,585	293,074
Bar, bolt, and rod ...	567,692	653,902	616,898
Other descriptions ...	227,701	273,785	287,138
Total tons	1,035,884	1,261,272	1,197,110

Declared value:—

	£	£	£
Pig iron	557,586	1,056,310	1,242,912
Bar, bolt, and rod ...	3,406,360	5,647,773	5,730,107
Other descriptions ...	2,720,330	4,141,339	4,695,023
	6,684,276	10,845,422	11,668,042
Hardwares & cutlery	2,691,697	3,665,051	3,869,313
Machinery and mill work	1,251,360	1,985,536	1,932,963
Total	10,627,333	16,496,009	17,470,318

EXPORTS OF BRITISH IRON, INCLUDING UNWROUGHT STEEL, TO THE UNITED STATES IN THE YEARS 1853 AND 1854.

	1853.	1854.
Pig iron........tons	158,476	114,102
Bar, bolt, and rod ... „	411,301	340,245
Other descriptions „	84,754	85,849
Total tons........	654,531	540,196

Yours faithfully,

HARRY SCRIVENOR.

Liverpool, 24th March, 1855.

DECIMAL COINAGE.

19, Gloucester-terrace, Hyde-park, March 19, 1855.

SIR,—The following memorandum has no pretence whatever, in any part of it, to be original. It contains, I believe, *nothing* which is not to be found in the publications of the Decimal Coinage Association, or in the admirable papers of Professor De Morgan. The substitution of *numbers* for *names* was suggested, a considerable time ago, in a letter published by Mr. Good, master of the Dock-yard School at Milford Haven.

The only excuse which I have for sending this paper to you is, to exhibit the process which (after trying a good many others) presents the matter in the easiest form to my own mind, and is that by which I should adapt myself to the use of the new coinage, if at once called upon to do so. Every person, probably, will have to make some such system for himself. Some will do it in one way, some in another. The best way for *each person* will be that which is the most readily intelligible to *himself*. I submit this paper simply as the chart of the course which I have myself found the easiest, and which may perhaps help some one else in the same direction, who, like myself, is no very expert arithmetician, and who has no vocation to discuss alloys and exchanges.

I had intended to deliver the substance of the following paper at the discussion to which you did me the honour of inviting me on the 14th of February, but the number of far better authorities on the same subject, who wished to speak, prevented me from doing so.

I remain sir,

Your obedient servant,

R. R. W. LINGEN.

DECIMAL COINAGE.

Suppose the desired act of Parliament passed, making the farthing the 1000th part of the pound sterling, ordering the coinage of a 10-farthing piece (cent), and the keeping of all public accounts in decimals, viz:—

Sovereigns,
Florins,
Cents, and
Mils (farthings).

In the first place, these *names* would never have to be used, except when it was actually required to mention the coins. For instance, "how will you have change for this pound?" Answer,

5 florins,
30 cents,
200 mils.

Under *all other* circumstances, the coins would be simple "counters," and, so long as there was one coin for each decimal stage, in order to mark each stage for public observation, it would not matter how many intermediate coins there might be, so long as they were always taken and spoken of as *counters*.

Thus, while the pure decimal system of *accounts* would be represented in *coinage* by the,

Sovereign,
Florin,
Cent,
Mil,

counting respectively as,

1000,
100,
10,
1,

it would not, in the least degree, confuse this scale, but

would simply be a practical supplement to it for purposes of exchange, to have coins in circulation *counting*—

500
250
125
50
25
5
4
2

or, in present *names*,

half-sovereign,
crown,
half-crown,
shilling,
sixpence,
rimmed-penny,
light-penny,
half-penny.

The only difficulty would arise during the interval in which these intermediate coins continued to be thought of *by their old names*, which suggest the old non-decimal scale, *instead of by their value as counters in the decimal scale*.

Of course, in all new issues of coin, such of these coins as it might be found expedient to retain in use would be stamped with their value as *counters*, on the reverse side.

It is a point of great importance, for the popular comprehension, to bring the change before the country under the form of *counting up* units, instead of *dividing* wholes into parts. It is easier to understand that 10 florins make 1 pound, than that 1 florin is $\frac{1}{10}$th of 1 pound. *Fractions* are ideas not readily grasped, more especially when vulgar and decimal fractions have to be thought of together; but a number representing *so many units* is simple for every one. Each new coin, therefore, should have the Queen's head on one side, and on the other, *not a name only*, *nor a fraction at all*, but its numerical value as a counter; *e.g.*, the new coin answering to half-a-crown, if retained, should be stamped on the reverse, 125; and so on of the rest.

If the whole country were placarded with tables of this sort,* as London now is with cab fares, people would not long be at a loss to know what it meant when they saw a pair of boots ticketed 725, or tea at 200 per pound. The coins in their pockets would count up the sum, and certain *figures* would soon come to be as completely identified with the values most common in exchange, as other *names* now are with such values. For instance, 75 would stand for eighteenpence, and would very soon come to suggest the same value with equal familiarity, and with equal unconsciousness on the part of the speaker.

Mr. Hugo Reid would make the florin the highest unit of account, omitting the cent as a separate name. The latter point is not material, and the reason which suggests it holds good throughout, viz., to use our money as *counters* in a system of simple arithmetic.

Mr. Reid's reason for taking the florin as the highest unit of account rests on the fact that we lose ourselves in estimating the parts of 1000, but readily carry in our head those of 100. This is quite true, and there is no doubt that, under a decimal system of coinage and accounts, our mental reference in the small payments of every-day life will be to the florin (or two shilling piece) = 100; wherein 75, 50, 25, will soon establish themselves as resting-places of familiar import. It will not long embarrass us to connect the value of two shillings with every figure in the hundred's place. As often as we see three figures the process we shall at first go through will be—

1. So many of 2s.
2. Such and such a proportion to 2s.

Thus 915 = 18s. and something under 6d.

These mental conversions will continue to be made only so long as it takes us to substitute a *double* shilling instead of a *single* one in our minds as a standard of value in measuring petty payments. As soon as the double shilling shall have rooted itself as the standard of such payments, and as soon as the parts of 100 shall also have become familiarly associated with common values, the stage of difficulty will be over.

No one would be embarrassed by the thousand's place, because he would at once detach it from the other three figures, as he now detaches the £ column from the *s.* and *d.* columns, and thinks of pounds by themselves.

The preponderance of argument for retaining the pound is not to be resisted.

The habitual use of numbers instead of names has this great advantage—that, supposing measures as well as coins and money accounts to be decimalised, we might get rid of the whole vocabulary of each separate table, since it would be enough to say 500 *sterling*, 500 *weight*, 500 *length*, 500 *surface*, 500 *liquid*, &c. *Time* is not equally an open question. Figures, *e.g.*, 500, standing alone, and without any qualifying addition, would continue to denote abstract number.

* SOVEREIGN	=	1000
Half-sovereign		500
Crown		250
Half-crown		125
FLORIN		100
Shilling		50
Sixpence		25
CENT		10
†Rimmed Penny		5
†Light Penny		4
Halfpenny		2
MIL or FARTHING		1

† One or other of these should be the measure of the fourpenny and threepenny pieces.

Proceedings of Institutions.

BRIGHTON.—The half-yearly report of the committee of the Railway Literary and Scientific Institution, states that the library now contains 2,200 volumes, and duplicate copies of those works most read will shortly be put into circulation. Since the last report the number of members has increased 130, making the total number 464. The following classes are in operation :—Rea ing, writing. and arithmetic; mechanical drawing; French; and dancing. The receipts and expenditure each amounted to £153

MEETINGS FOR THE ENSUING WEEK.

MON. Architects, 8. Mr. T. L. Donaldson, "On the Architectural Medals of Classic Antiquity, more particularly in reference to the Civil Edifices."
Chemical, 8.
Statistical, 8. Mr. J. W. Gilbart, F.R.S., "A Ten Years' Retrospect of London Banking."

TUES. Royal Inst. 3. Dr. Tyndall, "On Voltaic Electricity."
Civil Engineers, 8. Mr. B. Burleigh, "On the Construction of Railway Crossings and Switches."
Linnæan, 8.
Pathological, 8.

WED. London Inst., 7.
Society of Arts, 8. Dr. D. B. Reid, "Notes on the Revision of Architecture in connection with the Useful Arts. With a Sketch of the Ventilation at St. George's Hall, Liverpool."
Geological, 8. 1. Prof. Merian, "On the Cassian Beds, between the Keuper and the Lias, in the Vorarlberg." 2. Rev. W S. Symonds, "Fossils from the Keuper at Pendock, near the Malverns." 3. Capt. Garden, "On a Cretaceous Formation in Natal, South Africa. With a Notice of the Fossils, by Mr. W. H. Baily." 4. Dr. Sutherland, "On the Geology of Natal."
Royal Soc. Literature, 8½.

THURS. Royal Inst. 3. Mr. G. Scharf, jun., "On Christian Art."
Antiquaries, 8.
Royal, 8½.

FRI. Royal Inst., 8½. Mr. T. H. Huxley, "On Certain Zoological Arguments commonly adduced in favour of the Hypothesis of the Progressive Development of Animal Life in Time."

SAT. Asiatic, 2.
Royal Inst., 3. Dr. Du Bois Reymond, "On Electro-Physiology."
Medical, 8.

PATENT LAW AMENDMENT ACT, 1852.

APPLICATIONS FOR PATENTS AND PROTECTION ALLOWED.

[*From Gazette, April 5th,* 1855.]

Dated 19th March, 1855.

605. B. Cook. Chester-street, Kennington—Consuming smoke.
607. J. Rimmell, Covent-garden—Substitute for turpentine. (A communication.)
609. R. Howson, Lancaster—Screw-propeller.
611. J. Taylor, Southwark—Consuming smoke.
613. P. Roehrig, Paris—Alimentary substance.
615. J. Smalley, Wigan—Railway carriage axles.
617. A. R. Terry, 1, Adelphi-terrace—Copying letters.

Dated 20th March, 1855.

619. A. White, Great Missenden—Swinging-beds.
620. J. Musgrave, Bolton-le-Moors—Steam-engines.
621. W. Taylor, Poolstock, Wigan—Pickers for power looms.
622. T. M. Tell, and F. Squire, 74, King William-street—Weighing machine for detecting base coin.
623. T. Stevenson, Little Bolton—Gasing yarns.
625. C. Marsden, Kingsland-road—Tent poles.
624. Earl of Aldborough, Wicklow—Aerial navigation.
626. E. T. Bellhouse, Manchester, and D. Longsdon, Grafton-street, Fitzroy-square—Materials for coverings of buildings.
628. A. E. L. Bellford, 32, Essex-street, Strand—Governor. (A communication.)
629. I. Rogers, North Haverstraw, U.S.—Treating iron ores.
630. A. V. Newton, 66, Chancery-lane—Forming moulds for casting. (A communication.)

Dated 22nd March, 1855.

631. W. Miller, North Leith—Prevention of smoke.
632. J. Morrison, Birmingham—Metallic pens.
633. T. C. F. Lecour, Paris—Locomotion on canals and rivers.
634. J. Biden, Gosport—Marine engines.
636. M. Semple, Plymouth—Railway breaks.
637. W. MacNaught, Rochdale—Spinning machinery.
638. C. Carnell, Philadelphia—Bricks.
639. J. S. Russell, Millwall—Ship building.

Dated 23rd March, 1855.

640. G. Whyatt, Openshaw—Machinery for cutting piled goods.
641. J. H. Johnson, 47, Lincoln's-inn-fields—Combing machinery. (A communication.)
642. J. H. Johnson, 47, Lincoln's-inn-fields—Hydraulic motive power engines. (A communication.)
643. H. J. Morton, Leeds—Gasometers.
644. C. F. Behn, Commercial Sale Rooms, City—Moulds for casting metal. (A communication.)
645. F. Ransome, Ipswich—Artificial stone.
646. W. Young, Queen-street, Cheapside—Fire-places.

Dated 24th March, 1855.

647. J. Willis, 75, Cheapside—Umbrella and parasol frames.
648. J. L. Bachelard, 3, Charles-terrace, Old Kent-road, and H. Harvey, 73, Denbigh-street, Pimlico—Animal manure.
649. U. Scott, Duke-street, Adelphi—Carriages.
650. R. J. Jesty, King's-cross—Indicating apparatus between railway carriages.
651. D. Elder, jun., Glasgow—Moulding metals.
652. J. Niven, Keir—Paper and textile materials.
653. T. F. E. Clewe, Paris—Locomotive engines, tenders and railway carriages.
654. Major-Gen. G. G. Lewis, C.B., Woolwich, and J. Gurney, St. James's-street—Knapsack, convertible into a bed, a litter, or a tent.
655. W. Brown, Gresham-street—Preparing sewing silk.
656. L. F. Edwards, New Bridge-street—Furnaces. (A communication.)

Dated 26th March, 1855.

658. R. S. North, Gorton, Manchester—Permanent way and sidings.
660. J. Gedge, 4, Wellington-street South, Strand—Machinery for forming curves. (A communication.)
662. C. A. Barrett, W. Exall, and C. J. Andrewes, Reading—Threshing machines.
664. J. H. Johnson, 47, Lincoln's-inn-fields—Flax-dressing machinery. (A communication.)
666. C. A. Busson, Paris—Feeding apparatus, applicable to machines for treating textile materials.
661. F. Crossley, M.P., Halifax—Mosaic rugs.
670. A. W. Williamson, University College, Gower-street—Fire-places.

WEEKLY LIST OF PATENTS SEALED.

Sealed April 3rd, 1855.

2138. John Perry, Hunslet Old Mill, Leeds—Improvements in preparing wool for combing.
2157. Thomas Roberts and John Dale, Manchester—Improvements in obtaining and treating extracts from certain dye woods, and in apparatus for obtaining such extracts.
2165. Valentine William Hammerich, Altona, Holstein—An improved construction of buoyant mattress.
2190. Arthur Dobson, Belfast—Improvements in looms for weaving.
2197. John Coope Haddan, Chelsea—Improvements in the manufacture of cannon, and of projectiles for the same.
2214. Lionel John Wetherell, Compton street, Clerkenwell, and Augustus Johann Hoffstaedt, Albion-place—Improved construction of pump.
2204. Robert Walter Winfield, Birmingham—Improvements in tubes and rods used in the construction of articles of metallic furniture.
2243. Thomas Allan, Adelphi terrace—Improvements in applying electricity.
2246. William Joseph Smith, Stretford, Lancaster—Improvement in buttons.
2261. Charles Cowper, 20, Southampton-buildings, Chancery-lane—Improvements in preparing to be spun and in spinning silk waste.
2264. Isaac Adams, Massachussetts, U.S.—Improvements in machinery for printing.
2270. William Henderson, Cannon-street—Improvements in treating certain ores and alloys, and in obtaining products therefrom.
2285. Peter Armand le Compte de Fontaine Moreau, 4, South-street, Finsbury—Improvements in bleaching, dyeing, and preparing hemp and flax to be spun. (A communication.)
2993. William Boutland Wilkinson, Newcastle-on-Tyne—Improvements in the construction of fire-proof dwellings, warehouses, and other buildings, or parts of the same.
2299. Charles Blake, St. Leonard's—A method of preventing or lessening the injurious effects arising from collisions at sea and on other navigable waters.
2305. John Coope Haddan, Chelsea—Improvements in projectiles and in machinery for manufacturing the same.
2401. Antoine Edouard Brisbart Gobert, Montmirail (Marne)—A new kind of stamping press.
2550. Edward Hammond Bentall, Heybridge, Essex—An improved construction of locomotive steam-engine.
2573. John Collis Browne, Weston-super-Mare—Improved wrapper, applicable as a coat and other covering.
263. Godfrey Pattison, Glasgow—Improvements in machinery for dressing and finishing woven goods or fabrics.

Sealed April 5th, 1855.

2170. Henry Crosley, Camberwell-grove—Improvements in the manufacture of wadding for cannon and fire-arms.
2177. Robert Cruise, Manchester—Improvements in machinery or apparatus for stopping railway carriages.
2179. Thomas Shaw and Richard Dixon, Preston—Improvements in slubbing, roving, and jack frames employed in the preparation of cotton and other fibrous substances.
2207. Thomas Edwin Moore, 3, Great Titchfield-street, Oxford-street—Improvements in apparatus for sharpening knives, scissors, and other similar edged tools.
2268. John Rickhuss, Worcester, and Charles Toft, St. John, Bedwardine—Improvements in the manufacture of parian, porcelain, china, and earthenware.
2300. Claude François Vauthier, Dijon—Improvements in blowing machines.
2316. Archibald Craig, Paisley—Improvements in the manufacture of railway wheels.
2408. Lancelot Kirkup, Orchard-street, Newcastle-on-Tyne—Improvements in anvils.
2553. Thomas Cooper, Isle of Wight—Improvements in the construction of pipes, and in the mode of joining the same.
2671. William Porter Dreaper, Bold-street, Liverpool—Improvement in the manufacture of pianofortes.
237. James Howard, Bedford—Improvements in ploughs.
295. Alfred Vincent Newton, 66, Chancery-lane—Improved mode of constructing dry docks.
312. Charles Barnard and John Bishop, Norwich—Improvements in apparatus for cutting vegetable substances.

Sealed April 7th, 1855.

2186. François Alexandre Nicholas Delsarte, No. 3, Rue Croix-Boissière, Paris—A new mode of and apparatus for tuning pianos and other kinds of stringed instruments.

WEEKLY LIST OF DESIGNS FOR ARTICLES OF UTILITY REGISTERED.

No. in the Register.	Date of Registration.	Title.	Proprietors' Name.	Address.
3701	April 4.	Gas Fire Brick	Benjamin Wheeler	Albert-street, Nottingham.
3702	" 5.	Fastenings for Portfolios, and other covers containing Papers and Documents	T. De la Rue and Co.	Bunhill-row.
3703	" 6.	The Alliance Shawl	Foster, Porter, and Co.	47, Wood-street.
3704	" 7.	Improved Can, Jar, or Case	Wm. Greig, Robert Taylor and John Chandler	Richardson-street, Bermondsey.
3705	" 10.	Clasp or Buckle	Nehemiah Brough	Cox-street, Birmingham.
3706	" 11.	Improved Sling-action Case Beer Engine	Thomas Frederick Hale	Narrow Wine street Works, Bristol.